10-1968

Pool Studies

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5

TWENTY-SIXTH ANNUAL REPORT

Part Two

ANDROSCOGGIN RIVER AND POOL
Dissolved Oxygen and Other Tests: Reaeration

1968

Introduction. This portion of the Report contains results and comparisons of analytical, Test data and certain observations. Emphasis is given to the dissolved oxygen content in the river water and to reaeration. Biochemical Oxygen Demand statistics are recorded in Parts Three and Four. This year the Rumford Center sampling station was abandond after twenty-six years of useful service. Two periods were chosen for study, the month of August and an eight-week period, July fifteen to September seven.

Dissolved Oxygen. With the exception of the Pool, dissolved oxygen conditions were better than had been anticipated, due to the unusual river flows during June and the first week of July.

Bell's. River water passing this station during the summer, had a large dissolved oxygen content usually above 60% saturation. Tests made twice a week indicate a daily average of 104,900 lbs. for the June first to September forteen period. The averages for certain previous years are:

1968	104,000	lbs/day	1965	70,200	lbs/day
1967	82,400	" "	1964	87,500	" "
1966	88,900	" "			

The variations are due cheifly to changes in the season's average flow.

2. Gorham, N.H. From June seven to September 28 the river water analyses for dissolved oxygen were recorded as 6.00 ppm or higher on eighty days. Only eight days, (July 17-25 incl.) were reported below five ppm; the low for the season was 3.80 ppm, July 17, (water temperature 24°C), when the B.O.D.5 was 9.5 ppm. Last year the lowest D.O. was 5.10 ppm and in the 1966 season there were no reports below 6.00 ppm. The average daily loads of available oxygen were:

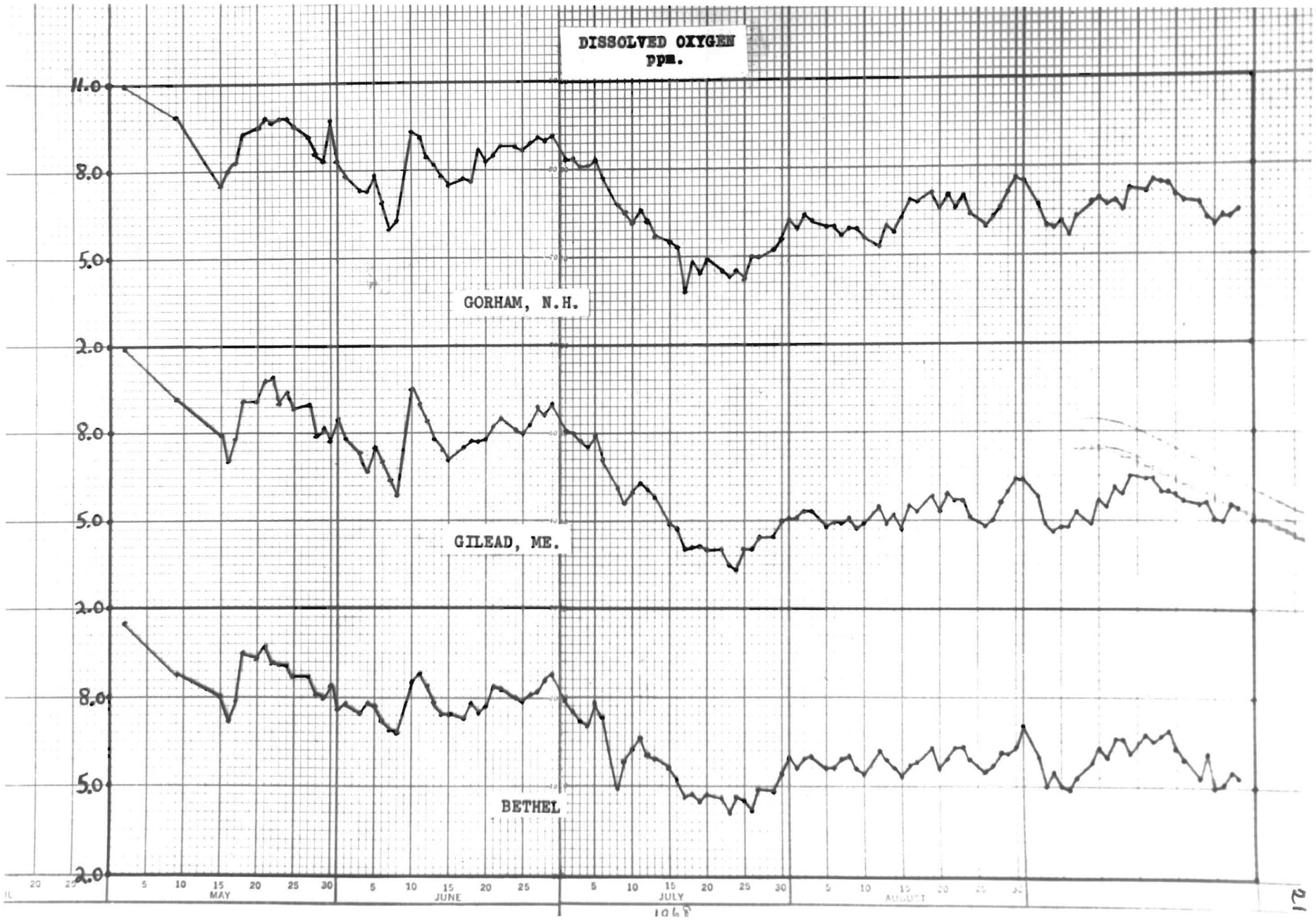
1968	95,800 lbs	1965	57,660 lbs
1967	66,590 lbs	1964	85,820 lbs
1966	82,660 lbs	1963	90,240 lbs

3. Gilead. This station is located so close to the Maine-New Hampshire boundary that, the analyses of water obtained here may be considered as substantially the same as that crossing the boundary line. Prior to 1967 only weekly tests were made since then daily analyses have been conducted.

This season twenty-seven daily samples were reported below FIVE ppm, four of which were below FOUR ppm, the lowest was 3.25 ppm on July 24.

	Below FIVE ppm	Below FOUR ppm	Lowest ppm
1968	27 days	4	3.25
1967	27 "	0	4.30

To maintain five ppm at the boundary, reaeration would have been necessary on twenty-seven days, on July 24 about 20,000 lbs of added oxygen would have been required to meet the legal "C" standard.


DISSOLVED OXYGEN
ppm.
11.0
8.0
5.0
GORHAM, N.H.
2.0
8.0
5.0
GILEAD, ME.
2.0
8.0
5.0
BETHEL
2.0
MAY
JUNE
JULY
AUGUST
1968

4. Virginia Bridge. The statistics tabulated below indicate the magnitude of the problems involved should SIX ppm dissolved oxygen be required at all times in the water passing this station. The 1968 low was 3.7 ppm, July 27.

1968	40	days	below	FIVE	ppm	68	days	below	SIX	ppm
1967	25	"	"	"	"	45	"	"	"	"
1966	0	"	"	"	"	8	"	"	"	"
1965	3	"	"	"	"	21	"	"	"	"
1964	1	"	"	"	"	12	"	"	"	"

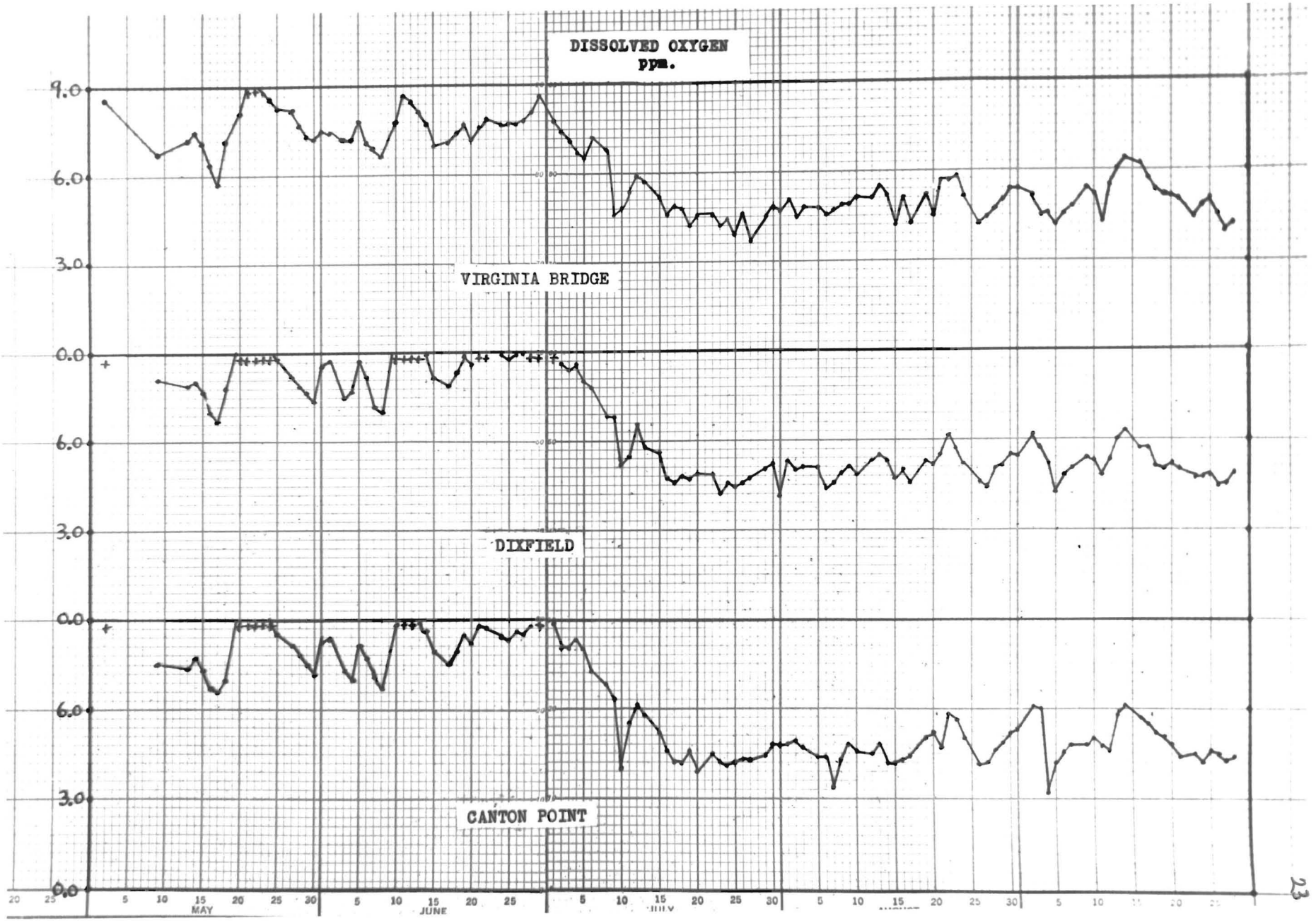
Obviously the quality of the water here has seriously deteriorated during the past five years. If 1965 flows had occurred this year, it is very probable that on some days anaerobic waters would have been present at Virginia Bridge. During the eight week study period the daily average available D.O. was 60,250 lbs (4.8 ppm); B.O.D.5 load for the period was 29,900 lbs.

Natural Reaeration from Gorham to Virginia Bridge was somewhat larger than last season. During August the daily average loss of D.O. in this sector was 9,500 lbs; the B.O.D.5 loss was 61,800 lbs. Reaeration appears to be about 1220 lbs per mile per day; August 1967 average was 1040 lbs per mile per day.

5. Dixfield. (Swan's Pit) During August the daily average Dissolved Oxygen at this location was 5.1 ppm or 63,300 lbs; the accompanying B.O.D.5 load was 87,800 lbs, (7.1ppm); a D.O. deficit of 24,500 lbs.) The seasons lowest recorded D.O. is 4.2 ppm, July 23.

1968°	0	days	below	FOUR	ppm	29	days	below	FIVE	ppm
1967°	5	"	"	"	"	32	"	"	"	"
1966*	0	"	"	"	"	0	"	"	"	"
1965*	4	"	"	"	"	24	"	"	"	"
1964*	0	"	"	"	"	7	"	"	"	"

°Swan's Pit
*Dixfield Bridge


DISSOLVED OXYGEN
ppm.
9.0
6.0
3.0
VIRGINIA BRIDGE
0.0
6.0
3.0
DIXFIELD
0.0
6.0
3.0
CANTON POINT
0.0
20 25 5 10 15 20 25 30 5 10 15 20 25 5 10 15 20 25 30 5 10 15 20 25 30 5 10
MAY
JUNE
JULY

6. Canton Point Bridge. Systematic sampling was begun in 1967 and continued during the 1968 season. The lowest recorded Dissolved Oxygen was 3.2 ppm on September four. Fifty days were below five ppm but only three below four ppm. During August the daily average available oxygen was 58,700 lbs (4.7 ppm) for a B.O.D.5 load of 77,200 lbs (6.2 ppm). Natural reaeration from Virginia Bridge to Canton Point was calculated as 1,060 lbs per mile per day; the 1967 estimate was 1,020 lbs per mile per day.

1. Virginia Bridge	60,800	lbs D.O. per day
2. Canton Point	58,700	" " " "
Loss	2,100	" " " "
3. B.O.D.5 loss (R-CP)	18,960	lbs per day
4. D.O. loss	2,100	" " "
5. Reaeration 15.9 miles	1,060	" " "

7. Riley Dam. Seventy days were reported as having dissolved oxygen below FIVE ppm, thirty-eight days below FOUR ppm and two days below THREE ppm. The seasons low is 2.8 ppm, July 25, the 1967 low is 1.7 ppm (August 18). Oxygen conditions were slightly better this year, due to the large June and early July river flows.

REAERATION at Riley Dam. Comparison of the dissolved oxygen determinations made daily during the month of August at the Pump House below Riley Dam, with those with water sampled above the Dam, yielded the following statistics:

Pump House (27 tests)	78,900 lbs/day	6.3 aver. ppm	
Riley Dam (27 tests)	51,400 " "	4.1 " "	
D.O. gain	27,500 " "	2.2 " "	

The average temperature of the water was 19.9°C, maximum 22.6 and minimum 17.1°C, average flow 2321 cfs, maximum 2653 cfs and minimum 2154 cfs. For the eight week period, July 15 to September 7 the data are:

Pump House (47 tests)	80,400 lbs/d	5.7 aver. ppm	
Riley Dam (47 tests)	52,000 "	3.6 "	"
D.O. gain	28,400 "	2.1 "	"

For the two week period July 15-31 when the average water temperature was 23.7°C and the flow 2720 cfs the data are:

Pump House (15 tests)	84,400 lbs/d
Riley Dam (15 tests)	51,800 "
D.O. gain	32,600 "

Subtracting the 2.2 ppm dissolved oxygen gained from the Jay and North Turner statistics the August average D.O. probably would have been 3.7 and 1.8 ppm respectively. Disregarding probable figures, there is no doubt that without the Riley Dam reaeration conditions at North Turner and in the Pool would have resulted in a very serious additional shortage of dissolved oxygen.

8. Pump House. With the exception of B.O.D. all the usual tests are made on water entering the pump house about 0.6 mile downstream from the Dam. The data are recorded in the adjacent pages.

9. Jay. Due to the excellent reaeration at Riley there were:

1968	61 days above SIX ppm	6 days below FIVE ppm
1967	47 days " " "	8 " " " "

The seasons low was 4.3 ppm September 28. During the eight week period, July 15-Sept. 7, the available D.O. load averaged 74,700 lbs/d

PUMP HOUSE

April, May, June, 1968

Date	pH	TEMP. °C	DISSOLVED OXYGEN ppm	% Sat.
April				
25	6.6	8.8	9.8	
May				
2	6.5	9.8	10.5	
9	6.5	12.0	9.6	
13	6.5		7.8	
14	6.5	13.2	7.1	
15	6.5	13.5	9.7	
16	6.5	14.0	9.2	
17	6.4	15.1	7.1	
18	6.5	13.2	8.2	
20	6.4	10.3	9.8	
21	6.5	9.5	10.0	
22	6.5	10.0	11.1	
23	6.4	10.0	10.7	94.6
24	6.5	11.8	10.2	93.5
25	6.3	13.2	9.1	85.8
27	6.4	13.2	9.4	88.7
28	6.5	13.8	9.0	86.5
29	6.5	14.5	8.0	78.4
30	6.4	14.8	8.5	83.3
31	6.6	15.5	7.9	78.2
June				
1	6.6	16.0	8.2	82.0
3	6.5	15.2	8.4	82.4
4	6.5	16.6	9.0	92.7
5	6.5	15.2	8.8	86.2
6	6.5	16.0	8.5	85.0
7	6.5	18.0	7.8	82.1
8	6.5	18.2	7.6	80.0
10	6.5	16.0	9.1	91.0
11	6.5	12.8	10.8	100.
12	6.4	12.9	10.0	94.3
13	6.5	13.8	10.0	96.2
14	6.3	14.9	9.2	90.2
15	6.3	17.0	8.9	91.8
17	6.5	18.0	8.2	86.3
18	6.5	15.8	9.0	90.0
19	6.5	15.8	9.0	90.0
20	6.5	16.2	9.0	90.0
21	6.4	15.0	9.1	89.2
22	6.5	15.5	9.6	96.0
24	6.5	15.0	9.3	91.2
25	6.5	15.0	9.2	90.2
26	6.5	15.0	9.2	90.2
27	6.5	14.9	9.3	91.2
28	6.5	14.0	9.5	91.3
29	6.5	13.1	10.0	94.3

PUMP HOUSE

July, 1968

Date	FLOW cfs	pH	TEMP. °C	DISSOLVED OXYGEN ppm	% Sat.	lbs/d
1		6.7	16.9	9.7	100.0	
2		6.9	18.2	8.9	93.6	
3		7.1	18.5	8.7	91.8	
5		6.7	19.2	8.4	89.5	
6		6.7	19.7	7.3	79.3	
8		7.1	19.0	7.7	81.9	
9		7.1	20.2	6.5	70.6	
10		7.1	21.9	6.8	77.3	
11		7.1	20.8	6.6	73.3	
12		7.1	21.4	6.8	75.6	
13		6.8	22.5	6.7	76.6	
15	2975	7.1	23.4	6.5	74.7	104,202
16	2919	6.9	25.0	5.8	69.0	91,228
17	2838	6.9	26.0	5.5	67.1	84,112
18	2910	6.9	25.0	5.8	69.0	90,950
19	3114	6.9	26.5	5.4	66.2	90,617
20	3059	6.7	26.0	5.5	67.1	90,657
22	2793	6.6	24.0	5.8	68.2	87,296
23	2592	6.6	25.0	5.7	67.8	79,618
24	2560	6.5	24.0	5.7	67.0	78,632
25	2561	6.7	22.5	5.8	66.7	80,040
26	2498	6.8	22.5	4.8	54.5	64,613
27	2469	6.7	22.5	6.0	68.9	79,824
29	2503	6.5	21.9	5.9	67.0	79,580
30	2452	6.6	21.1	6.2	68.9	81,921
31	2371	6.4	20.4	6.5	70.7	83,044

PUMP HOUSE

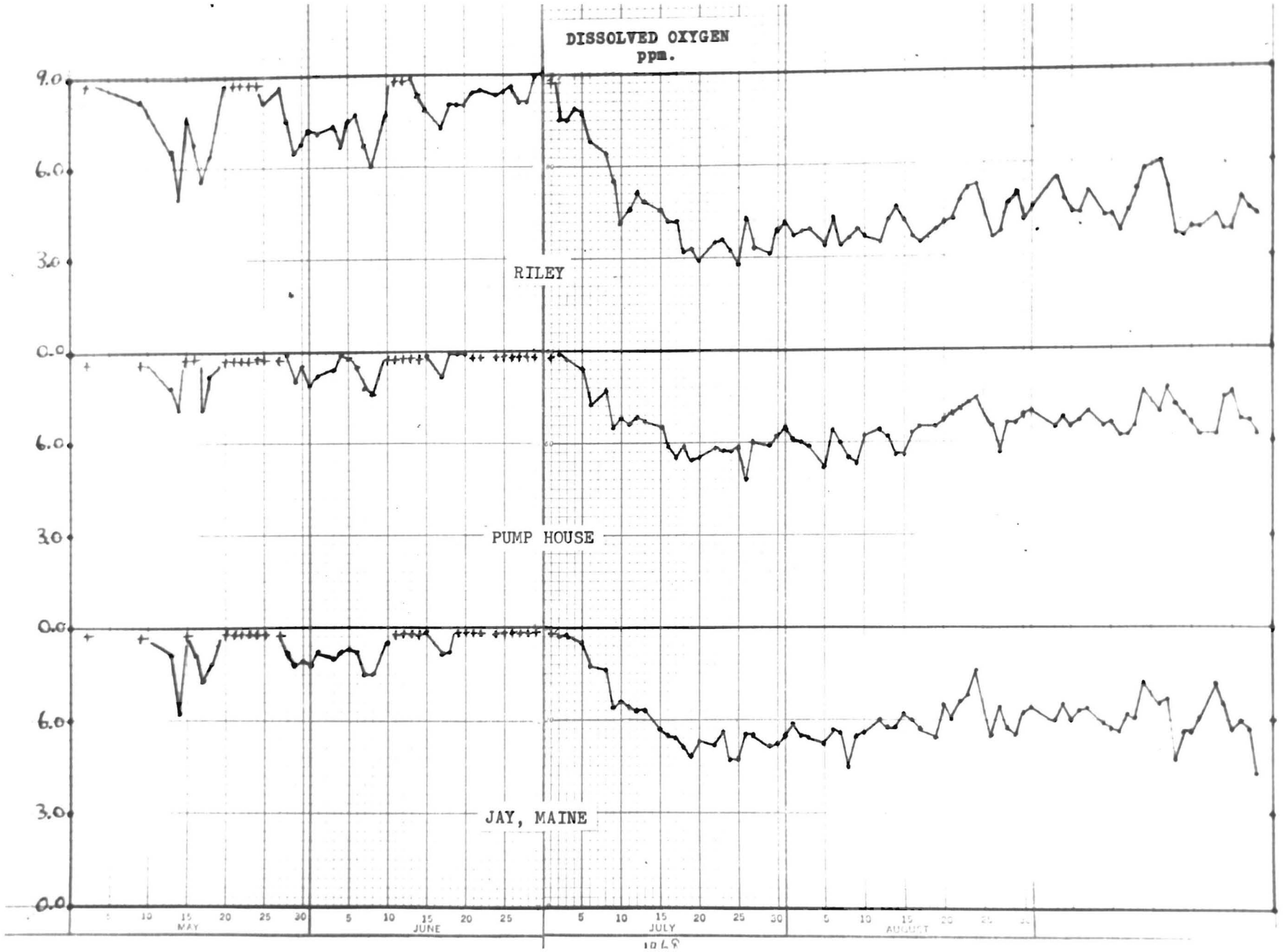
August, 1968

Date	FLOW cfs	pH	TEMP. °C	DISSOLVED OXYGEN ppm	% Sat.	lbs/d
1	2384	6.5	21.0	6.1	68.0	78,367
2	2354	6.3	20.8	6.0	66.7	76,110
3	2420	6.3	21.0	5.9	65.7	76,942
5	2320	6.5	22.6	5.2	60.0	65,011
6	2410	6.5	22.8	6.4	68.6	83,117
7	2319	6.5	21.1	6.0	66.5	74,982
8	2242	6.5	21.2	5.5	59.9	66,451
9	2359	6.5	21.4	5.3	59.0	67,368
10	2300	6.4	20.9	6.2	68.9	76,843
12	2283	6.4	19.8	6.4	69.6	78,733
13	2224	6.5	20.3	6.2	67.5	74,307
14	2179	6.5	20.4	5.6	60.8	65,755
15	2199	6.6	19.6	5.6	60.9	66,360
16	2154	6.6	19.6	6.3	68.6	73,124
17	2268	6.5	20.2	6.5	70.7	79,437
19	2322	6.5	19.3	6.5	69.2	81,335
20	2384	6.5	19.6	6.7	73.6	86,075
21	2641	6.5	19.2	6.9	75.0	98,200
22	2653	6.5	18.7	7.1	75.6	101,502
23	2385	6.7	18.3	7.3	76.8	92,557
24	2300	6.6	18.7	7.4	78.7	91,716
26	2300	6.5	20.8	6.5	72.2	80,561
27	2303	6.4	20.5	5.6	62.2	69,496
28	2230	6.5	19.5	6.6	71.7	79,312
29	2158	6.6	18.2	6.6	69.5	76,745
30	2231	6.5	18.3	6.9	72.6	82,952
31	2347	6.5	17.1	7.0	72.2	88,536
average	2321			6.3		78,900

PUMP HOUSE

September, 1968

Date	FLOW cfs	pH	TEMP. °C	DISSOLVED OXYGEN ppm	% Sat.	lbs/d
2	Holiday					
3	2167	6.5	19.2	6.5	69.2	75,900
4	2120	6.5	19.1	6.8	72.4	77,683
5	2080	6.9	19.5	6.5	70.8	72,658
6	2124	6.5	19.0	6.7	71.4	76,487
7	2401	6.5	18.2	7.0	73.8	90,566
9	2226	6.5	18.9	6.5	69.5	
10	2066	6.5	19.1	6.6	70.3	
11	2309	6.5	19.0	6.2	66.0	
12	2987	6.5	18.5	6.2	66.8	
13	2874	6.5	17.2	6.5	73.2	
14	2490	6.6	16.2	7.6	76.0	
16	2177	6.5	16.3	7.0	70.0	
17	2133	6.7	16.4	7.7	77.0	
18	2065	6.5	17.4	7.2	74.3	
19	2078	6.7	17.6	6.9	72.7	
20	2030	6.5	18.5	6.6	70.2	
21	2054	6.6	19.7	6.2	67.4	
23	1994	6.5	19.8	6.2	67.4	
24	1967	6.5	19.3	7.4	78.8	
25	2044	6.6	19.3	7.6	81.0	
26	2165	6.7	18.8	6.7	71.3	
27	2181	6.7	18.2	6.7	70.6	
28	2151	6.7	18.0	6.2	65.3	


DISSOLVED OXYGEN
ppm.
9.0
6.0
3.0
0.0
RILEY
PUMP HOUSE
JAY, MAINE
MAY
JUNE
JULY
AUGUST
1969

(5.7 ppm), the B.O.D.5 load was 63,300 lbs/d indicating a margin of 11,400 lbs D.O. per day. In the sector between Jay and Otis there was an average loss of D.O. during August of 15,900 lbs/d (1.3)ppm. This is an unusual high rate of loss which may be due to active benthal deposits.

10. Chisholm, Otis.(in) Livermore Falls. (out) Dissolved oxygen statistics for these two stations are:

Otis (in)	August	58,200	lbs/d	July 15-Sept.7		62,700	lbs/d
L.F. (out)	"	67,700	"	"	"	77,400	"
	Gain	9,500	"			14,700	"

These gains partially off-set the losses in the Jay-Otis sector.

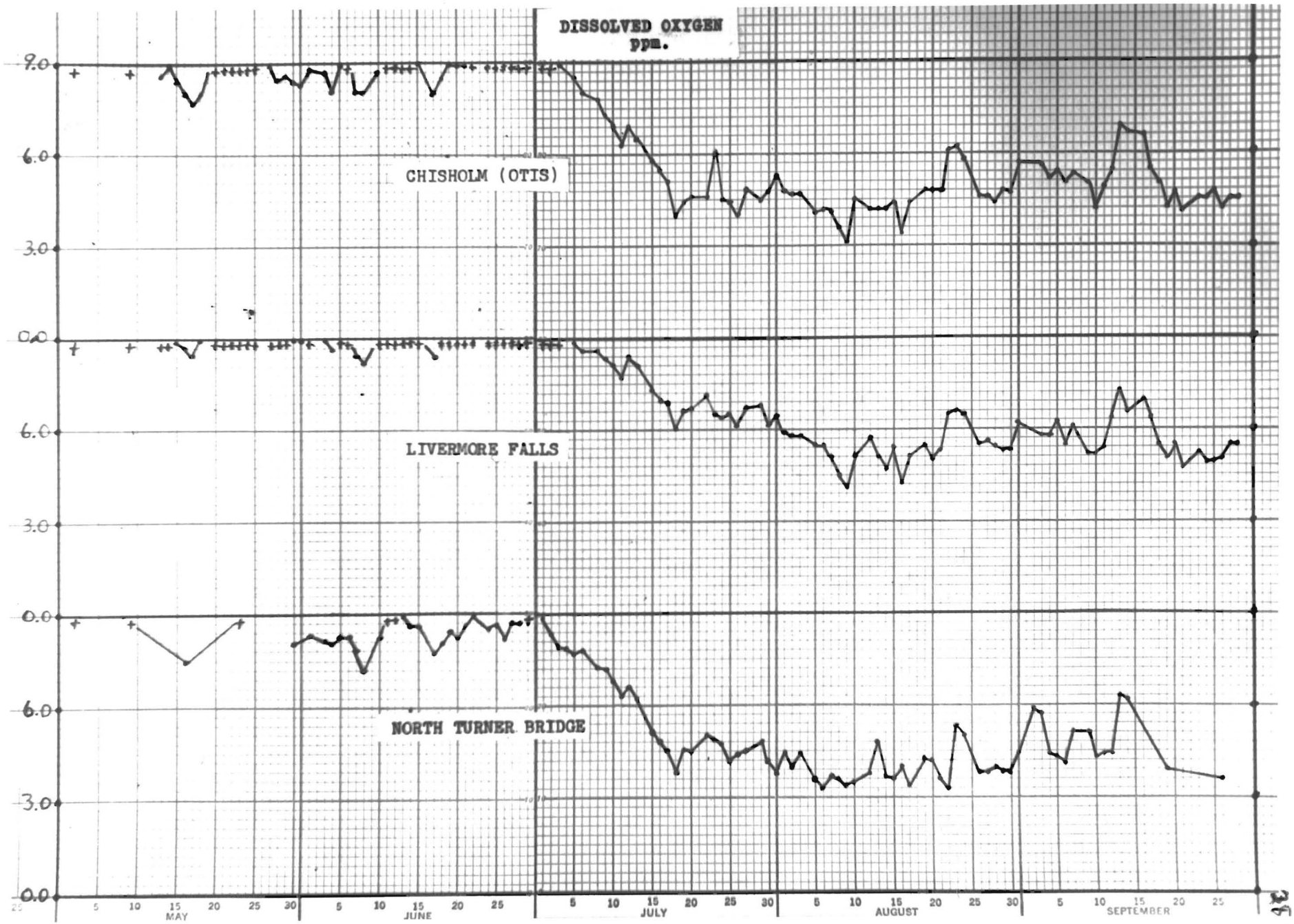
11. North Turner Bridge. The very high seasonal D.O. (5.89 ppm) load at this station is due to the large river flows during June and early July. After July 15 the average was much smaller (4.25 ppm). The lowest recorded D.O.'s were 3.35 ppm on August 8, and 3.30 ppm August 22.

	above FIVE ppm	below FOUR ppm
1968	47 days	20 days
1967	49 "	19 "
1966	19 "	51 "
1965	8 "	63 "
1964	30 "	14 "

Dissolved Oxygen. Summer Daily Averages

1968	5.89 ppm	1963	4.51 ppm
1967	5.17 "	1962	4.77 "
1966	4.04 "	1961	3.42 "
1965	2.23 "	1960	4.13 "
1964	5.44 "		

With 1965 river flows and 1968 production-pollution loads, with full allowance for Riley reaeration, the water entering the Pool probably would not contain more than two ppm dissolved oxygen and on some days would be anaerobic.


DISSOLVED OXYGEN
ppm.
9.0
6.0
3.0
0.0
CHISHOLM (OTIS)
LIVERMORE FALLS
NORTH TURNER BRIDGE
MAY
JUNE
JULY
AUGUST
SEPTEMBER

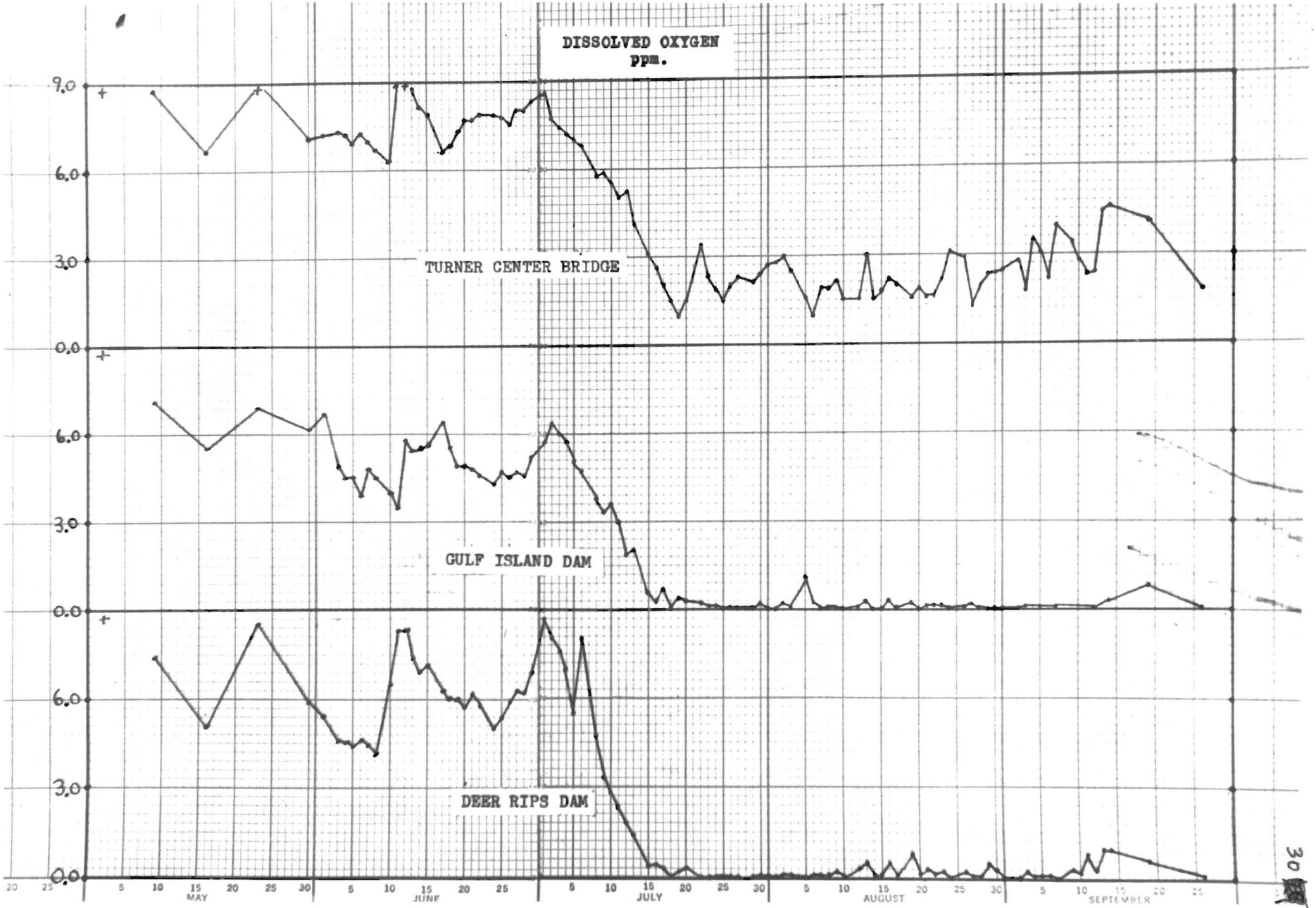
The averages calculated for the 1968 season are:

June 1 - Sept. 14	141,100 D.O. lbs/day		
July 15- Sept. 7	56,680 D.O.	"	" (4.0 ppm)
August	50,200 D.O.	"	" (4.25 ppm)

During the eight week period about 56,700 lbs/d of dissolved oxygen were available for the 87,500 lbs/day of B.O.D. ult. indicating that a daily reaeration of 30,800 lbs/day would be required to support the entering pollution load. Therefore, with large benthal oxygen demands the water becomes anaerobic in the southern end of the Pool and hydrogen sulfide then appears in varying concentrations.

12. Turner Center Bridge. Benthal activity in the sector between the two bridges consumes large quantities of oxygen. This August reaeration at North Turner Rips, the additional dissolved oxygen contributed by the Nezinscott River and the river reaeration appear to have increased the available oxygen by about 20,200 lbs. The measured loss of D.O. was 24,150 lbs/day, the total loss appears to be 24,150 + 20,200 or 44,350 lbs. D.O. per day. The average measured loss of B.O.D.5 was 2,800 lbs/d hence about 41,500 lbs/d of D.O. is required to meet some of the entering B.O.D. and the benthal demands.

This season fifty-five days were recorded below FIVE ppm and twenty days below TWO ppm. The lowest D.O.'s were recorded at 0.98 ppm on July 19 and August 6. During August the highest recorded Dissolved Oxygen was 3.0 ppm, forteen were below two ppm. If the flows had been at the 1965 rate during this August (1968), the water probably would have been, at or very near, anaerobic during the entire month. cf. Part Four of this Report.


DISSOLVED OXYGEN
ppm.
9.0
6.0
3.0
0.0
TURNER CENTER BRIDGE
GULF ISLAND DAM
DEER RIPS DAM
20 25 5 10 15 20 25 30 5 10 15 20 25 5 10 15 20 25 30 5 10 15 20 25 30 5 10 15 20 25
MAY
JUNE
JULY
AUGUST
SEPTEMBER

13. Deer Rips Dam. From July 15 to October 3, river water arriving at this Dam was very deficient in dissolved oxygen. During August the average D.O. was 0.18 ppm equivalent to 2,380 lbs/day, for the eight week period the averages were recorded as 0.15 ppm or 2160 lbs/day. From July 22 to 29 all D.O. tests were zero, from August first to sixth the highest D.O. was 0.08 ppm; many stability tests were below one day.

For all practical purposes the water may be considered anaerobic for about eight weeks. Fifty-six days were recorded below TWO ppm, fifty-three were below One ppm and eight were zero. If low flows had existed during June and early July, anaerobic conditions may have lasted at least three months.

If river flows are much lower than those of 1968 production of hydrogen sulfide probably will become a nuisance condition. Reaeration appears to be a requisite to prevent conditions becoming worse at this location next season. cf. Reaeration Report.

14. Lewiston. Water sampled at the Chestnut Street Bridge was of low quality from July 15 to the end of September; lower than any of the previous five years. Forty-four days the recorded Dissolved Oxygen was below ONE ppm and thirty-one days below 0.5 ppm.

Below ONE ppm		Below 0.5 ppm	
1968	44 days	1968	31 days
1967	35 "	1967	12 "
1966	26 "	1966	13 "
1965	0 "	1965	0 "
1964	1 "	1964	1 "

Dissolved Oxygen Summer Averages

Tons/day

	Location	1968	1967	1966	1965
1.	Bell's	52.45*	41.19*	44.43	35.11
2.	Gorham (Public Service)	47.90	33.29	41.33	28.83
3.	Gilead	46.45	32.91	38.96	29.57
4.	Virginia Bridge	58.20	37.22	46.52	32.31
5.	Canton Point Bridge	63.95	39.64		
6.	Riley	65.40**	33.62**	35.71**	14.01*
7.	Jay	84.95	48.74	48.55	12.34
8.	Chisholm	74.20	47.00	44.00	11.54
9.	Livermore Falls°	38.70			
10.	North Turner Bridge***	70.55	45.84	27.91	11.66
11.	Turner Center Bridge***	60.50	31.74	16.39	8.07
12.	Deer Rips Dam***	43.55	6.68	4.17	8.88

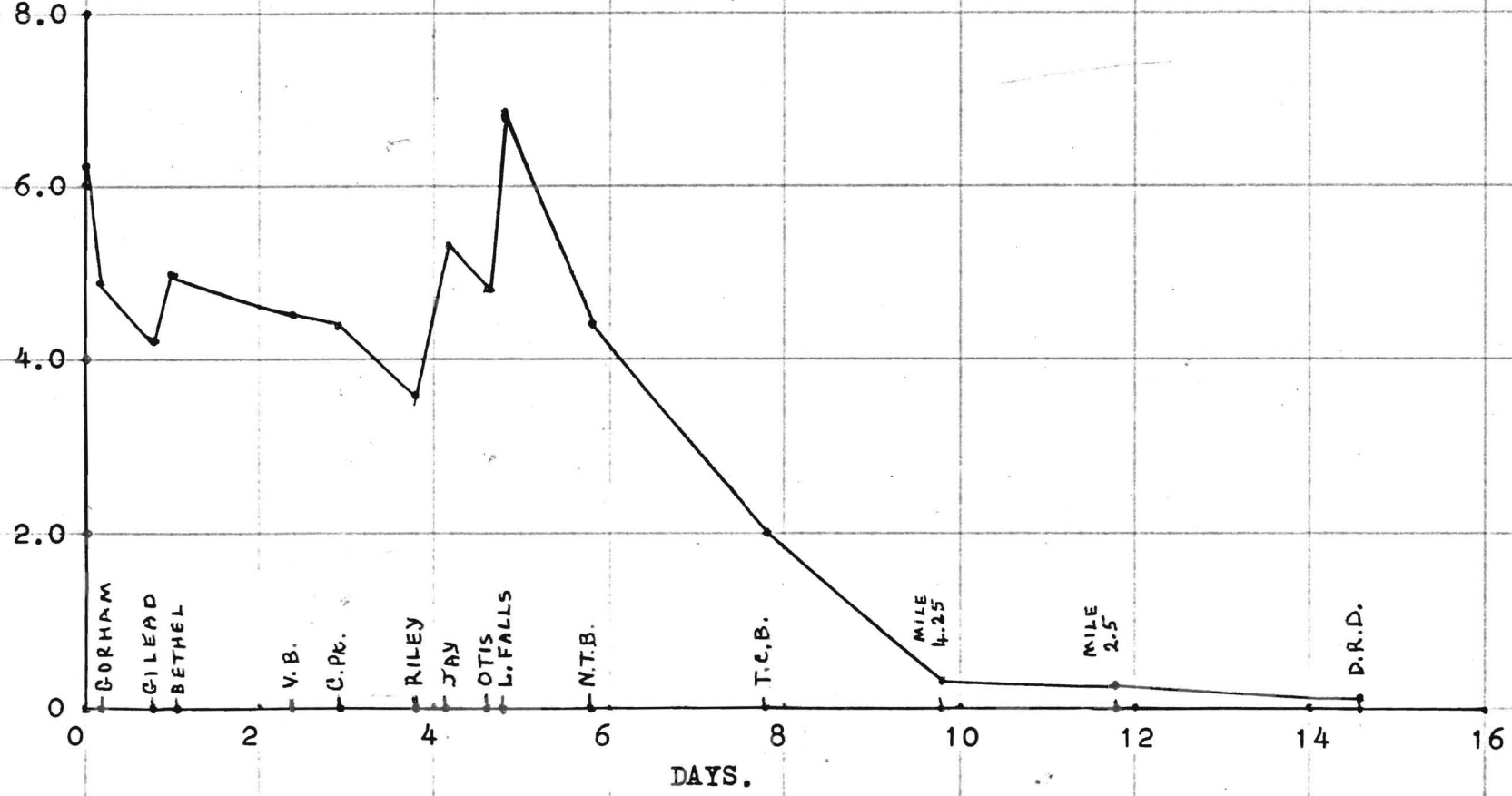
* Limited Data. Thursdays only 1968 Monday and Thursday
** All tests June-Sept.
*** Eleven Week Special Test Period 1967-1965; June 1 to Sept. 14
° July 15-Sept.7 1968

DISSOLVED OXYGEN

average ppm
July 15 - 31 1968

Flows. average.

Gorham	2149	cfs
Rumford	2536	"
G.I.Dam	2817	"



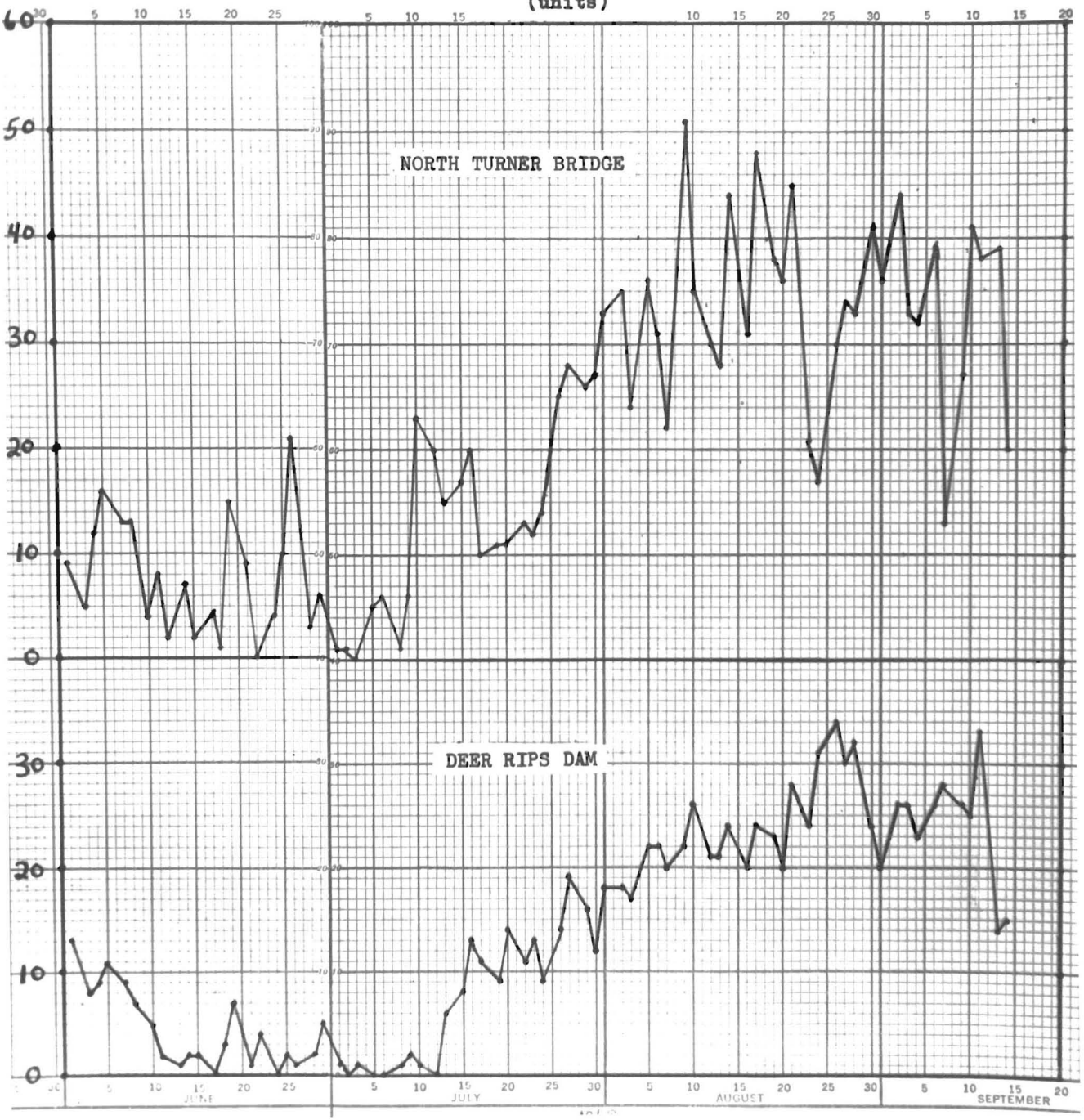
Instrumentation at Turner Center Bridge. During the summer the National Council for Air and Water Improvement installed instruments in the enclosure at Turner Center Bridge. The instruments were supplied by the Fairchild Company, Robertshaw Company and Union Carbide Corporation. The National Council will issue a report on the results obtained with each instrument. Several measurements were available, that for Dissolved Oxygen is of immediate interest. Casual comparisons appeared to favor the Fairchild installation.

Fish Kill. cf. Part One.

Tyrosin Lignin Test. A plot of the daily tests results obtained at North Turner Bridge and Deer Rips Dam indicates the variations which were recorded. The principal value of the test is an early warning of increased pollution arriving in the Pool.

pH. Determinations were made at all stations each week day. The median is approximately 6.5 but wide variations were recorded due to black liquor and other alkaline losses. The highest test reported this year was 9.8, at Jay on September 18, probably due to a local loss imposed upon higher alkalinity than usual from upstream. At the Gorham station, four days were recorded above 8.0, September 6, 12, 13 and 21. During July, fourteen determinations made at Dixfield were 7.0 plus. These tests indicate large losses of chemicals and money. Plans should be made to reduce them and to store the unavoidable ones.

TYROSINE TEST
(absorption)
(units)



Methylene Blue Stability. This test was conducted on water from Deer Ripe and Gulf Island Dam. A stability of one day and over was more frequent than expected but during the July 15 to August 6 and August 22 to 28 stabilities were limited to a few hours.

Test Comparisons. For the purpose of comparison, samples were taken by analysts from Brown Company and Oxford Paper Company at Bethel, at the same time and place, then tested for D.O. and B.O.D. Temperature and pH also were recorded.

Similar proceedures were conducted by analysts from Oxford Paper Company and International Paper Company at Riley. The results of the two series of tests are tabulated below.

Test Comparisons 1968

Bethel Station

Date	Brown Company		Oxford Paper Company	
	D.O.ppm	B.O.D.ppm	D.O.ppm	B.O.D.ppm
June 19	7.50	2.9	7.6	2.5
July 17	4.60	2.8	5.3	3.4
Aug. 14	5.50	4.65	5.6	7.0
Sept.11	6.00	4.8	6.0	6.8

Test Comparisons 1968

Riley Station

Date	Oxford Paper Company D.O.ppm	Oxford Paper Company B.O.D.ppm	International Paper Co. D.O.ppm	International Paper Co. B.O.D.ppm
June 6	7.6	2.4	7.7	3.5
13	8.7	2.9	8.9	3.1
20	7.9	2.2	8.0	2.9
27	8.1	2.4	8.1	2.7
July 11	4.5	3.1	4.6	3.5
18	3.3	2.3	3.2	2.9
25	3.2	2.9	2.8	3.0
Aug. 1	3.2	4.1	3.7	3.5
5	3.4	2.6	3.4	3.9
8	3.0	4.4	3.6	3.3
15	3.1	4.4	4.2	3.8
22	4.4	3.2	4.8	3.7
29	4.0	3.8	5.0	4.2
Sept. 5	3.4	3.6	4.4	2.6
12	3.9	4.2	4.4	3.6
19	3.5	5.2	3.6	3.0
26	4.0	4.0	4.8	4.2

ANDROSCOGGIN POOL

1968

PRELIMINARY REPORT

REAERATION, NITRATE.

by

Walter A. Lawrance

ANDROSCOGGIN POOL

1968

Preliminary Report

Introduction During the summer of 1968 the river water in the Pool from Mile 4.25 to Deer Rips Dam, was anaerobic or almost so from about mid-July to September seven. Odor conditions over this sector were more objectionable than they have been since 1960. Hydrogen sulfide in and around the Dams was present from mid-July to early October. A Central Maine Power supervisor stated that the generator commutators required more frequent cleaning than any year during the past six years. On August 23, hydrogen sulfide covered a considerable portion of the residential areas for about an hour.

River flows were above the thirty-one year average during June and July and slightly below the average in August. Conditions deteriorated rapidly about the middle of July initiated by the unusual high water temperatures. From July 22 to 30 the dissolved oxygen was zero in water sampled at Deer Rips Dam. An extensive fish kill occurred below Deer Rips Dam on July 22.

With the increase of more than 50,000 lbs. B.O.D. in 1968, if the flows had been approximately the same, circa 1700 cfs, as those during the summer and fall of 1965, very serious problems would have arisen. The accompanying Tables summarize production, pollution and Pool conditions. They are presented in detail in the final Annual Report.

The Androscoggin River Technical Committee, at the September 18 meeting in Rumford, decided that the conditions in the Pool this summer warrented study of means which might be employed to prevent conditions deteriorating to the nuisance levels. All calculations are based on a one ppm oxygen but this does not assume that one ppm would solve all the problems.

Ammonium Nitrate Addition. Experience in 1967 with sixty-two tons of Ammonium Nitrate, 60% solution, which was added at Turner Center Bridge was experimental and the results were inconclusive. The location is seven miles above Gulf Island Dam and about seven days time of passage. Addition was not continuous.

Nitrate Costs

1. Cost delivered at Turner Center $36.62 per ton
2. Solution is 60% One Ton = 720 lbs. Oxygen
3. 1800 cfs = 4.85 M.Tons per day
4. One ppm at 1800 requires 4.85 tons oxygen
5. One ppm oxygen at 1800 cfs requires
   13.5 tons Ammonium Nitrate $495.00 per day
   One ppm oxygen at 1900 cfs $530.00 " "
   One ppm oxygen at 2000 cfs $552.00 " "
6. Addition may be required for two months.

Advantages

1. Ammonium nitrate is available in Maine at a few hours notice.
2. Ease of addition, no new equipment required.
3. Minimum supervision.

Disadvantages

1. Degree of effectiveness is unknown
2. May increase slime and algae growth.
3. Addition at Turner Center probably is not as effective as location near the Dam. Nitrates are effective at near anaerobic conditions.

Oxygen Addition. Mechanical aeration of water has been employed on a large scale in many parts of the U.S.A. and abroad. The committees' opinion was that any reaerator considered should be of a type that could be successfully employed in secondary treatment, when those facilities are available.

Mr. Robert Drummond (I.P.Co.) office supplied the following information;

> An Aerator, circulation type, 60 H.P. motor on raft. 10 quotes varied from $9000 to 16,000, the higher priced contained more stainless steel.

Oxford Paper Company stated;

1. Cable, water proofed, costs about $7.00 per foot, 440 volt, 180 H.P. load.
2. $5000 for switches etc.
3. Power, at $60 per H.P. year; about $250 per week, allow $40.00 per day
4. Maintenance costs should not be very high.

Calculations to add one ppm of oxygen.

1. Assume 3 aerators 60 H.P. 180 H.P.
*2. Assume 2.5 lbs. Oxygen per H.P.H. (Literature 2 to 3 ppm).
3. Then 2.5 x 180 x 24 = 11,300 lbs. Oxygen per day.
4. At 1800 cfs, one ppm Oxygen requires 9,700 lbs. per day.

*Mr. McKeown (National Council) states 2.5 ppm is too high.

Aerator, installation, and switches costs would approximate $20,000. The cost of wire would depend on location.

Reaeration at Livermore Falls. Mr. Stevens stated at the committee meeting that the wheels at the Livermore Falls plant are locked so that the water flows through but does not turn them. If they were unlocked and air ducts installed an unknown but probably an appreciable amount of reaeration would be obtained. Some maintenance (lubrication, etc.) would be required. Several years ago

experiments were conducted at Otis, bleeding air by a hose resulted in one ppm and slightly higher reaeration, with a considerable loss of power. This latter situation would not be involved due to the fact that power is not being generated.

Oxygen added at this location would be very desirable at present pollution loads and more so under low flow conditions, cf theoretical plot accompanying this report.

Pulp Equivalent of Oxygen. Mr. Drummond requested data relating to the pulp production equivalent of added oxygen.

Calculations

1. Bleached pulp 60 lbs. B.O.D.5/ton or 96 lbs. B.O.D. ult./ton
2. Unbleached pulp 30 lbs. B.O.D.5/ton or 48 lbs. B.O.D. ult/ton
3. One pound B.O.D.5 requires one pound Oxygen
4. One ppm Oxygen at 1800 c.f.s. = 9,700 lbs.
5. Production cuts could occur upstream from the Pool, hence, B.O.D. ult. would be a better base for calculation.
6. One ton bleached pulp contributes 96 lbs. B.O.D. ult. or 96 lbs. demand of oxygen.
7. 9,700 lbs. of oxygen equivalent to 96 x 100 tons per one ppm/day
8. Unbleached 9,700 lbs. Oxygen equivalent 46 x 210 tons per one ppm/day
9. Under severe conditions each mill probably would have to cut at least 100 tons per day, to reduce the amount of hydrogen sulfide which may be formed upstream, and hopefully increase the D.O. entering the Pool.
10. At present sales values
    One ton bleached, $140; 100 x 140 = $14,000 per day
    One ton unbleached, $125; 210 x 125 = $26,250 " "

Conclusion

1. The benthal demand is a major problem, it is large and probably will not decrease under present production loads. Obviously, an early installation of primary treatment is the best solution for this problem.

2. The major objective is the oxidation of hydrogen sulfide to prevent nuisance conditions. Complete prevention of its formation, at even 2000 cfs flows, would be expensive and probably require 40,000 lbs. Oxygen per day at present production levels.

3. One ppm of hydrogen sulfide in the river water would require about 1.9 ppm Oxygen to convert it to sulfuric acid, assuming the reaction is complete.

4. At present production levels and the large benthal demands, with 1800 c.f.s. the hydrogen sulfide concentration could be 0.5 ppm, may be higher, and this could produce nuisance conditions.

5. The addition of one ppm of Oxygen in the region near the dams should lower the hydrogen sulfide content to 'safer levels' but under low flows may show little or no net increase in dissolved oxygen.

If the 1969 flows are lower than those of 1968 and temperature conditions and production about the same, then the volume of anaerobic water will be larger and there will be increase in the hydrogen sulfide content of the river water passing through the Pool.

Comparison of Costs

1. Nitrate. No initial costs
   Each one ppm of Oxygen at 1800 c.f.s. would cost $495.00 per day

2. Reaeration. Initial costs about $25,000 per unit or $75,000 for three.
   Each one ppm of Oxygen: power $ 40.00 per day
   maintenance 20.00 " "

3. Pulp Production Cuts.
   100 tons Bleached, each mill $14,000 per day
   3 x $14,000 = $42,000 " "

I am of the opinion that,

a. Reaeration probably is more effective than the use of nitrates.

b. The unlocking of the wheels and bleeding air into the system at Livermore Falls Mill should be accomplished to meet present conditions.

c. Reaeration, with at least three aerators, should be available next season.

d. Publicity should be favorable.